CLAIMS

What is claimed is:

1. A method of generating a high-resolution image from a generic low-resolution image, the method comprising:

   extracting a plurality of low-frequency primitives from a low-resolution image; and

   replacing one or more respective ones of the plurality of low-frequency primitives with corresponding primitives from stored training data to provide a high-frequency primitive layer of the low-resolution image.

2. A method as recited in claim 1, wherein the high-frequency primitive layer comprises a plurality of high-frequency primitives.

3. A method as recited in claim 1, wherein the stored training data comprises a plurality of primal sketch priors.

4. A method as recited in claim 1, wherein the stored training data is provided by comparing pairs of low-resolution and high-resolution versions of a same training image.

5. A method as recited in claim 1, further comprising normalizing the plurality of low-frequency primitives prior to the replacing.

6. A method as recited in claim 1, further comprising applying Markov chain inference to the high-frequency primitive layer to provide contour smoothness.

7. A method as recited in claim 1, further comprising interpolating the low-resolution image to provide a low-frequency image prior to the extracting.

8. A method as recited in claim 1, further comprising bicubically interpolating the low-resolution image to provide a low-frequency image prior to the extracting.

9. A method as recited in claim 1, further comparing:

interpolating the low-resolution image to provide a low-frequency image prior to the extracting; and

combining the high-frequency primitive layer with the low-frequency image to provide an intermediate image.

10. A method as recited in claim 1, further comparing:

interpolating the low-resolution image to provide a low-frequency image prior to the extracting;

combining the high-frequency primitive layer with the low-frequency image to provide an intermediate image; and

reconstructing the intermediate image to provide a high-resolution image.

11. A method as recited in claim 1, further comparing:

interpolating the low-resolution image to provide a low-frequency image prior to the extracting;

combining the high-frequency primitive layer with the low-frequency image to provide an intermediate image; and

reconstructing the intermediate image by applying backprojection to provide a high-resolution image.

12. One or more computer readable media storing computer executable instructions that, when executed, perform the method as recited in claim 1.

13. A method comprising:

extracting, at a training phase, a plurality of primal sketch priors from training data; and

utilizing, at a synthesis phase, the plurality of primal sketch priors to improve a low-resolution image by replacing one or more low-frequency primitives extracted from the low-resolution image with corresponding ones of the plurality of primal sketch priors.

14. A method as recited in claim 13, wherein the training data is provided by comparing pairs of low-resolution and high-resolution versions of a same training image.

15. A method as recited in claim 13, further comprising applying Markov chain inference in the synthesis phase to provide contour smoothness.

16. A method comprising:

hallucinating a low-frequency image (I_H^l);

extracting a high-frequency primitive layer ($I_H^{p^*}$) of the hallucinated low-frequency image;

combining the low-frequency image (I_H^l) and the high-frequency primitive layer ($I_H^{p^*}$) to provide an intermediate image (I_H^g); and

reconstructing the intermediate image (I_H^g) to provide a high-resolution image (I_H).

17. A method as recited in claim 16, further comprising interpolating a low resolution image (I_L) to provide the low-frequency image (I_H^l).

18. A method as recited in claim 16, further comprising bicubically interpolating the low resolution image (I_L) to provide the low-frequency image (I_H^l).

19. A method as recited in claim 16, wherein the high-frequency primitive layer ($I_H^{p^*}$) is provided as follows:

$$I_H^{p^*} = \arg\max p(I_H^p | I_H^l) = \arg\max p(I_H^l | I_H^p) p(I_H^p).$$

20. A method as recited in claim 16, wherein the reconstructing applies backprojection to the intermediate image (I_H^g) to provide the high-resolution image (I_H).

21. A method as recited in claim 16, wherein the reconstructing applies backprojection to the intermediate image (I_H^g) to provide the high-resolution image (I_H), wherein the backprojection is provided as follows:

$$I_H^{t+1} = I_H^t + (((I_H^t * h) \downarrow s - I_L) \uparrow s) * p$$

where p is a backprojection filter; I_H^t and I_H^{t+1} are input image and output images at times t and $t+1$; h is a blurring operator determined by the point spread function of the imaging sensor; $\uparrow s$ is an up-sampling operator by a factor s; and $\downarrow s$ is a down-sampling operator by a factor s.

22. One or more computer-readable media having instructions stored thereon that, when executed, direct a machine to perform acts comprising:

extracting a plurality of low-frequency primitives from a low-resolution image; and

replacing one or more respective ones of the plurality of low-frequency primitives with corresponding primitives from stored training data to provide a high-frequency primitive layer of the low-resolution image.

23. A computer-readable media as recited in claim 22, wherein the acts further comprise normalizing the plurality of low-frequency primitives prior to the replacing.

24. A computer-readable media as recited in claim 22, wherein the acts further comprise applying Markov chain inference to the high-frequency primitive layer to provide contour smoothness.

25. A computer-readable media as recited in claim 22, wherein the acts further comprise interpolating the low-resolution image to provide a low-frequency image prior to the extracting.

26. A computer-readable media as recited in claim 22, wherein the acts further comprise bicubically interpolating the low-resolution image to provide a low-frequency image prior to the extracting.

27. A computer-readable media as recited in claim 22, wherein the acts further comprise:

interpolating the low-resolution image to provide a low-frequency image prior to the extracting; and

combining the high-frequency primitive layer with the low-frequency image to provide an intermediate image.

28. A computer-readable media as recited in claim 22, wherein the acts further comprise:

interpolating the low-resolution image to provide a low-frequency image prior to the extracting;

combining the high-frequency primitive layer with the low-frequency image to provide an intermediate image; and

reconstructing the intermediate image to provide a high-resolution image.

29. A computer-readable media as recited in claim 22, wherein the acts further comprise:

interpolating the low-resolution image to provide a low-frequency image prior to the extracting;

combining the high-frequency primitive layer with the low-frequency image to provide an intermediate image; and

reconstructing the intermediate image by applying backprojection to provide a high-resolution image.

30. One or more computer-readable media having instructions stored thereon that, when executed, direct a machine to perform acts comprising:

extracting, at a training phase, a plurality of primal sketch priors from training data; and

utilizing, at a synthesis phase, the plurality of primal sketch priors to improve a low-resolution image by replacing one or more low-frequency primitives extracted from the low-resolution image with corresponding ones of the plurality of primal sketch priors.

31. A computer-readable media as recited in claim 30, wherein the acts further comprise applying Markov chain inference in the synthesis phase to provide contour smoothness.

32. A system comprising:

a primal sketch priors extraction module to extract a plurality of primal sketch priors from training data; and

an image hallucination module to utilize the plurality of primal sketch priors to improve a low-resolution image by replacing one or more low-frequency primitives extracted from the low-resolution image with corresponding ones of the plurality of primal sketch priors.

33. A system as recited in claim 32, wherein the training data is provided by comparing pairs of low-resolution and high-resolution versions of a same training image.

34. A system as recited in claim 32, further comprising a Markov chain inference module to provide contour smoothness.

35. An apparatus comprising:

means for extracting a plurality of low-frequency primitives from a low-resolution image; and

means for replacing one or more respective ones of the plurality of low-frequency primitives with corresponding primitives from stored

training data for providing a high-frequency primitive layer of the low-resolution image.

36. An apparatus as recited in claim 35, further comprising means for normalizing the plurality of low-frequency primitives prior to the replacing.

37. An apparatus as recited in claim 35, further comprising means for applying Markov chain inference to the high-frequency primitive layer to provide contour smoothness.

38. An apparatus as recited in claim 35, further comprising means for interpolating the low-resolution image to provide a low-frequency image prior to the extracting.

39. An apparatus as recited in claim 35, further comprising means for bicubically interpolating the low-resolution image to provide a low-frequency image prior to the extracting.

40. An apparatus as recited in claim 35, further comprising means for:

interpolating the low-resolution image to provide a low-frequency image prior to the extracting; and

combining the high-frequency primitive layer with the low-frequency image to provide an intermediate image.

41. An apparatus as recited in claim 35, further comprising means for:

interpolating the low-resolution image to provide a low-frequency image prior to the extracting;

combining the high-frequency primitive layer with the low-frequency image to provide an intermediate image; and

reconstructing the intermediate image to provide a high-resolution image.

42. An apparatus as recited in claim 35, further comprising means for:

interpolating the low-resolution image to provide a low-frequency image prior to the extracting;

combining the high-frequency primitive layer with the low-frequency image to provide an intermediate image; and

reconstructing the intermediate image by applying backprojection to provide a high-resolution image.